

# The C# implementation of numerical calculation process on nonlinear equation solutions

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## ABSTRACT

Solutions in the process of resolving numerical methods, especially "Solutions of Non-Linear Equations", are determined by several criteria including 1. Solutions will be obtained if the tolerances found from numerical calculations are less than or equal to the specified tolerances, depending on the criteria of the question. 2. The solution will be obtained if the function value  $f(x_{n+1})$  reaches zero (0). 3. The solution will be obtained if the value of  $x_{n+1}$  has a constant value (no change). In some observations of manual efforts to find non-linear equations solutions, students cannot do the calculation perfectly. This is due to lack of understanding of teaching materials or modules and also the algorithms that are difficult to grasp. Moreover, the calculation has to be done for several times iterations in order to obtain the expected results. Comparing the results of calculations done manually using Microsoft Excel and the result of calculations using numerical applications created using C# programming language, it concludes non-linear equations manual calculation to get one of the roots of non-linear functions tend to not completed in a short time so the error rate and accuracy cannot be measured. The calculations performed using Microsoft Excel, obtained the error rate reaches 0.158% and the accuracy rate reaches 99.842%. Calculations performed using numerical applications using the C# programming language obtained error rate reached 0.004% and accuracy rate reached 99.996%.

### Keywords:

C#  
Non-Linear Equation  
Numerical calculation  
Microsoft excel

## I. Introduction

The development of science and technology is currently moving rapidly. Its development has entered all sectors, so it is easier for people in searching for information and innovation in accordance with the wishes and expectations. Information gained from the advancement of science and technology does not rule out the possibility of being creative and innovative.

Numerical method is one of the subjects that according to some students are classified into complicated courses. The degree of difficulty experienced is due to the process of finding the desired solution requires several times the workmanship of a repetitive nature. Because it is repetitive it takes a long time to break it in accordance with the requirements that have been determined. The basic concept of numerical calculation, specifically in the splitting of "Non linear Equations" in both open and closed methods, uses several algorithms which include several criteria : the process stops if the tolerances generated in numerical calculations are less than or equal to the tolerances specified in the case, the process will terminate if the function value of  $f(x_{n+1})$  or  $F(c)$  has reached zero, the process stops if the value of  $x_{n+1}$  or "c" is constant.

From some cases, solving numerical problems using manual methods often does not provide the correct end result, which is caused by a fairly complicated manual calculation process and a long enough understanding that the students' spirit to work on the problem becomes weak and even absent. The process of numerical execution for the "Nonlinear Equation" solution using Ms. Excel, has assisted students in understanding the concepts and algorithms used, either for closed methods or open methods, but has not provided the desired answers, although the degree of difficulty of students in solving existing problems diminishes.

In the development of science and technology, especially information technology, gives us complete information but needs to be translated with realization and creative action. One of the



creative actions in question is the ability of human in solving complicated problems using programming languages that have been generated by many people: Fortran, Pascal, Cobol, C++, Visual Basic, Delphi, Java, C#, and others.

To answer the problem, this research will provide an overview of the extent to which C# programming language influences the understanding of concepts and algorithms on numerical methods for the settlement of "Nonlinear Equations". The benchmark of problem-solving when using a programming language, especially the C# programming language, is done by comparing the time efficiency level of the workmanship using the manual methods, the Ms. Excel and C# programming languages and the level of accuracy of the answers generated.

## II. Theoretical

### A. Definition

The theoretical foundation used in this study covers several things including application definition, system definition, numerical method definition, nonlinear equation definition, C# concept, framework .net, and definition of efficiency:

- Application Definition

According to Eka Noviansyah (2008: 4) application is the use and application of a concept that becomes a subject. Applications can also be interpreted as a computer program created to help humans in performing certain tasks. Meanwhile, according to Anisyah (2000: 30), the application is the application, use or addition. From the above understanding, it can be concluded that the application is a software that serves to perform various forms of work or specific tasks such as the application, use, and addition of data.

- System Definition

According to Jerry Fitzgerald, Ardra F. Fitzgerald and Warren D. Stallings, Jr., defines that the system is a procedure, defined "A procedure is a precise sequence of the stages of instruction that describes What to do, Who did it, when was it done and how do it[1]. Understanding the system according to Abdul Kadir (2005: 1) in the book Introduction of Information Systems, which states that "System is a set of interrelated or integrated elements intended to achieve a goal". According to Ludwig Von Bertalanffy defines that "The system is a set of interconnected elements in an interrelation between the elements with the environment" [2].

- Definition of Numerical Methods

Numerical method is a technique or a way to analyze and solve problems in the field of engineering and science by using mathematical calculation operations. Operation of mathematical calculations in numerical methods is usually done repeatedly through iteration. When done manually, takes a long time and the possibility of one very large because it needs accuracy.

- Definition of Non Linear Equation

The solution of a non linear equation is to compute the root of a non-linear equation with one variable  $x$ ,  $f(x)$ , or generally written  $f(x) = 0$ . Example of a nonlinear equation [3]:

$$f(x) = 3x^2 + 3x - 6 \quad (1)$$

$$f(x) = 2x^3 + 2x^2 + 3x + 6 \quad (2)$$

$$f(x) = 0.5x^4 + 0.25x^3 + 0.75x^2 + 2x + 4 \quad (3)$$

Some examples of problems that require solving non linear equations are as follows: determination of maximal and minimal non linear functions, calculating the constant value of the matrix and determinants, which usually occurs in linear system problems, the determination of the point of intersection of some non linear functions, which are widely used for graphical calculation purposes. The solution of the nonlinear equation is the determination of the roots of nonlinear equations, the root of an equation  $f(x) = 0$  is the values of  $x$  which cause the value of  $f(x)$  is zero, the root of the equation  $f(x)$  is the intersection point between the curve  $f(x)$  and  $x$  axis [4].

- C-Sharp (C#)

C# is one of the most powerful capabilities in Framework.NET. C# created in line with Framework development.NET, C# itself developed by Microsoft. In its application C-Sharp (C#) promises the productivity, flexibility and ease of existing applications of Visual Basic, Java and C++. C# adopts the ability of previous application merge. Microsoft created C# along with the creation of Framework.NET. Chief Architect in making C# is Anders Hejlsberg who previously played a role in the making of Borland Delphi and Turbo Pascal. C# promises the productivity and ease of being in Visual Basic with the capabilities and flexibility available in C/C++. According to the language specification, "C# (pronounced "C Sharp ") is a simple, modern, object-oriented, and type-safe programming language. It will soon be familiar to C and C++ programmers. C# combines the high productivity of Rapid Application Development (RAD) languages and the raw power of C++". To achieve this high productivity the difficult concepts of C++ are simplified and new features are added. This may seem similar to Java, which is why C# can be considered as a Java cousin [5].

- Framework.NET

Similar to C-Sharp (C#), Framework.NET was developed by Microsoft in the year span from 2001 to 2002. Framework.NET is a development of DOS and WIN 32 previously created by Microsoft. The emergence of problems encountered in the world of programming, encourage the development activities of programs that are able to overcome the problems appropriately and easily. Framework.NET is one of the programs that have strong software concepts in the form of Common Language Runtime (CLR) and class library.NET.

- Definition of Efficiency

Efficiency is defined by several experts with different languages and perspectives. According to some experts, efficiency is defined as follows: Understanding efficiency according to Mulyamah (1987; 3) namely: "Efficiency is a measure in comparing the plan use of input with the use of realized or other actual use" Understanding efficiency according to SP. Hasibuan (1984: 233-4) cited H. Emerson's statement as "Efficiency is the best comparison between input (input) and output (the result between profit with sources used), as well as optimal results achieved by the use of resources limited. In other words, the relationship between what has been resolved ".

#### B. Related research

According to Asminah in his research "Implementation of C# in Finishing Non Linear Equations", explains that testing is done empirically by comparing two groups of students, where the first group will be delivered the teaching materials through direct explanation of the lecturers without the help of software that has been made, while the second group will be given explanation of these teaching materials by combining the use of the software through a visual display on the screen accompanied by an explanation of the lecturer concerned [6]. According to Asminah and Vivi Sahfitri in his research "Implementation And Analysis of Software Accuracy Level of Completion of Non Linear Equations Using Fixed Point Iteration Method and Bisection Method", explains that the result of solving one case of non linear equation is considered average time that is not too long because the time of settlement less than 1 second compared to the way it works manually. Judging from the error tolerance of the Bisection method is better than the fixed point iteration method seen from the number of iterations and the average time required for the settlement of one case. That the complexity of non-linear problem solving is affected by the degree factor of equation, and the fault tolerance value. [7].

### III. Research Methodology

In conducting this research, in order to achieve the desired goal, then carried out the stages of research as follows:

- Determination of respondent sample: Respondent sample to 40 students of "Sekolah Tinggi Teknologi Hamzanwadi". The sample determination was taken from 20 students who have GPA below 3.00 and 20 students who have a GPA above 3.00

- The process of collecting data: Data collection is done to obtain information about the extent to which the ability of students in solving numerical problems. The data was collected by taking 40 student samples with details of 20 students who have a GPA below 3.00 and 20 students who have a GPA above 3.00.
- Students who made the respondents, do the work of the problems with 3 methods or stages, among others: 1. Manual process workmanship. 2. Process work done using Ms. application Excel. 3. Process work done using C# application. The process of working on numerical problems using C# applications implemented after the application using the C# programming language has been completed.
- Solving numerical problems is done on non linear equations using 5 methods, among others: bisection method, falsi regula method, Newton Rapshon method, Secant method and Fixed Point Iteration method.
- Recapitulation of preliminary data: data obtained from the process of numerical problems, collected in accordance with the stages of the manual stages, excel stages and application stages/C# programming language. The data obtained is used to analyze the effect of C# application in helping students solve the problems given.
- Data Processing: Data processing obtained from the previous stages, done using an excel application or rapidminer application to determine the effect of C# programming language. To determine the level of efficiency and the level of accuracy generated, it is searched using several algorithms. The results of this algorithm serve as a basis in the analysis and discussion of research results. Data Analysis: The data analysis process is carried out to find out or obtain some things including: the average time of settlement done manually, the average completion time is done using the Ms. application Excel, the average time spent using the C# programming language, the calculation of the error rate and the level of accuracy
- Drawing conclusions: drawing conclusions based on results of processing and data analysis. This is important to determine the next steps that need to be done and as reference material in subsequent research using different programming languages.

#### IV. Results and Discussion

##### A. Calculations manually

Manual calculations performed on 5 sample questions with a maximum processing time of 300 seconds, as shown in Table 4.1, Calculations performed manually, when viewed from the time of completion, cannot be inferred, this is because until the time limit specified, cannot be completed. This has an impact on the level of accuracy produced, can not be determined.

Table 1. Recapitulation of calculation results manually.

N	Question Sample	Bi	R	N	Se	IT
1	$F(x) = x^2 + 3x - 4$	x	x	x	x	x
2	$F(x) = x^2 + 3x - 18$	x	x	x	x	x
3	$F(x) = x^2 - 7x - 18$	x	x	x	x	x
4	$F(x) = x^3 + 3x^2 + 2x + 5$	x	x	x	x	x
5	$F(x) = 2x^3 + 5x^2 + 4x + 6$	x	x	x	x	x

<sup>a</sup> Description: Bi: Bisection, RF: Regula Falsi, NR: Newton Raphson, Sect: Secant, ITT: Fixed Point Iteration.

##### B. Calculations using Ms. Excel

Calculations performed using Microsoft excel. The time required to complete is still below the predetermined limits with an accuracy rate of 100.00% for the sample questions 1, 100.00% for sample questions 2, 100.00% for sample questions 3, 99.3% for sample no 4 and 99.9% for the sample question 5. The average accuracy obtained from 5 sample questions is 99.842%. The results calculations using Ms. Excel showed in table of 4.2 below.

Table 2. Recapitulation of calculation results using Ms. Excel.

Item	Question Sample				
	1	2	3	4	5
Analytic Value	1,00	3,00	9,00	-	-
Bisection	1,00	3,00	9,00	2,90	2,21
Regula Falsi	1,00	3,00	9,00	-	-
Numeric Value	Newton	1,00	3,00	9,00	2,90
	Rapshon	1,00	3,00	9,00	2,21
	Secant	1,00	3,00	9,00	-
	Fixed Point	1,00	3,00	9,00	2,90
	Iteration	1,00	3,00	9,00	2,21
Average	1,00	3,00	9,00	2,91	2,22
% Error	0,00	0,00	0,00	2,90	2,21
				0,70	0,09
				%	%
The error rate		0,158 %			
% Accuracy	100	100	100	99,3	99,9
	%	%	%	%	1 %
Level of accuracy		99,842 %			

### C. Calculation using C# application

Calculations performed using numerical applications using C# programming language, obtained error rate reached 0.004% and accuracy rate reached 99.996%. The results calculations using Ms. Excel showed in table of 4.3 below.

Table 3. The calculation results using the C# application

Item	Question Sample				
	1	2	3	4	5
Analytic Value	1,00	3,00	9,00	-	-
Bisection	1,00	3,00	9,00	2,90	2,21
Regula Falsi	1,00	3,00	9,00	-	-
Numeric Value	Newton	1,00	3,00	9,00	2,82
	Rapshon	1,00	3,00	9,00	2,03
	Secant	1,00	3,00	9,00	-
	Fixed Point	1,00	3,00	9,00	2,90
	Iteration	1,00	3,00	9,00	2,21
Average	1,00	3,00	9,00	2,90	2,21
% Error	0,00	0,00	0,00	-	-
				2,88	2,17
				0,00	0,01
				6 %	6 %
The error rate		0,004 %			
% Accuracy	100	100	100	99,9	99,9
Level of accuracy		99,996 %			

## V. Conclusion

From the results of research done manually, using Microsoft Excel and using numerical applications created using C# programming language, can be concluded, among others:

Manually calculated, the error rate and the desired accuracy cannot be obtained because manual calculations for nonlinear equations with the rank of more than 2 cannot be resolved within the specified time. Calculations performed using Microsoft Excel, obtained the error rate reached 0.158%

and the accuracy rate reached 99.842%. Calculations performed using numerical applications using C# programming language, obtained error rate reached 0.004% and accuracy rate reached 99.996%. From the error rate and accuracy data obtained, it is known that the calculations performed using numerical applications using the C# programming language, resulted in a smaller error rate than other calculation methods and resulted in a more accurate accuracy than other calculations. For the improvement and improvement of numerical applications using the C# programming language, it is necessary to do by the next researcher on several things, among others: This numerical application mostly applies to non linear equations which are the simple question, it is necessary to develop a more complex nonlinear equation, especially for non-linear trigonometric equations. The research is still referring to the constant value of "c" and the value of  $f(x) = 0$ , it is necessary to do accuracy level research using other programming language which is based on the predetermined tolerance value

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